



IFMP Seminar

Date Monday, April 27, 2026, at 14:50

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Zoom: 633 2801 2201, Passcode: IFMP2025-6

Speaker **Philip Willke**

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Title **Quantum Science with Single Atoms and Molecules on Surfaces**

Abstract The quantum nature of a physical system often emerges from its fundamental building blocks and demands a deep understanding to leverage its benefits for future quantum technologies. In this talk, I introduce how spin systems on surfaces can act as a new platform for coherent quantum control. In particular, I show how the combination of electron spin resonance (ESR) with scanning tunneling microscopy (STM) enables the detection, control, and manipulation of individual spin centers with atomic spatial resolution and extremely high energy sensitivity. Building on the first demonstrations of ESR on single atoms on surfaces [1], I will introduce the basic principles of this technique and show how it allows quantum systems to be investigated one atom at a time. As examples, I discuss high-resolution magnetic sensing that resolves magnetic dipole interactions as well as hyperfine coupling between single electron and nuclear spins [2,3]. Beyond sensing, these spin systems can be coherently driven and engineered as prototype quantum bits.

I will highlight current research directions in the field and in my group, including the extension of coherent control from single atoms to individual molecules [4,5] as well as spin defects on surfaces. Finally, I will discuss recent developments in our group that connect this platform to new experimental techniques, such as atomic force microscopy, and to new material systems, including superconductors.

[1] S. Baumann *et al.*, *Science* **350**, 417–420 (2015).

[2] P. Willke *et al.*, *Nat. Phys.* **15**, 1005–1010 (2019).

[3] P. Willke *et al.*, *Science* **362**, 336–339 (2018).

[4] X. Zhang *et al.*, *Nat. Chem.* **14**, 59–65 (2022).

[5] W. Huang *et al.*, *Nat. Commun.* **16**, 5208 (2025).

[6] K.H. Au-Yeung, W. Huang, *et al.*, arXiv:2602.22301 (2026).

Host: A. Singha